Claims

[c1] 1.An axial flux machine comprising:

a rotatable shaft;

a rotor disk coupled to the rotatable shaft;

a permanent magnet supported by the rotor disk;

a soft magnetic composite stator extension positioned in parallel with the rotor disk and having slots;

soft magnetic composite pole pieces attached to the stator extension and facing the permanent magnet, each comprising a protrusion situated within a respective one of the slots, each protrusion shaped so as to facilitate orientation of the respective pole piece with respect to the stator extension;

electrical coils, each wrapped around a respective one of the pole pieces.

[c2] 2. The machine of claim 1 wherein the slots comprise quasi-rectangular slots and the protrusions comprise quasi-rectangular protrusions.

[c3] 3.The machine of claim 1 wherein the protrusions extend from ledges of the pole pieces which are substantially parallel to the stator extension.

[c4] 4. The machine of claim 1 further comprising a circuit board situated adjacent to the stator or extension and electrically coupled to the electrical coils.

[c5] 5.The machine of claim 4 wherein the circuit board comprises a circuit pattern configured for proper sequencing of the electrical coils.

[c6] 6.The machine of claim 1 wherein each pole piece comprises a base portion around which a respective electrical coil is wrapped and a trapezoidal shield portion extending over at least part of the respective electrical coil.

[c7] 7.The machine of claim 6 wherein the pole pieces are optimally shaped to minimize leakage flux between adjacent pole pieces while maximizing magnetomotive force linking the electrical coils.

[c8]

8. The machine of claim 6 wherein the trapezoidal shield portion has a plurality of heights with a first height in a first region being longer than a second height in a second region, the second region being closer to a pole-to-pole gap than

the first region.

[c9] 9.An axial flux machine stator comprising:

a soft magnetic composite stator extension having slots;

soft magnetic composite pole pieces attached to the stator extension, each comprising a protrusion situated within a respective one of the slots, each protrusion shaped so as to facilitate orientation of the respective pole piece with respect to the stator extension;

electrical coils each wrapped around a respective one of the pole pieces.

[c10] 10. The stator of claim 9 wherein the slots comprise quasi-rectangular slots and the protrusions comprise quasi-rectangular protrusions

[c11] 11.The stator of claim 9 wherein the protrusions extend from ledges of the pole pieces which are substantially parallel to the stator extension.

[c12] 12.The stator of claim 9 further comprising a circuit board situated adjacent to the stator extension and electrically coupled to the electrical coils.

[c13] 13.The stator of claim 12 wherein the circuit board comprises a circuit pattern configured for proper sequencing of the electrical coils.

[c14] 14.The stator of claim 9 wherein each pole piece comprises a base portion around which a respective electrical coil is wrapped and a trapezoidal shield portion extending over at least part of the respective electrical coil.

[c15] 15.The stator of claim 14 wherein the trapezoidal shield portion has a plurality of heights with a first height in a first region being longer than a second height in a second region the second region being closer to a pole-to-pole gap than the first region.

[c16] 16.An axial flux machine comprising:

a rotatable shaft;

a rotor disk coupled to the rotatable shaft;

a permanent magnet supported by the rotor disk;

a soft magnetic composite stator extension positioned in parallel with the rotor disk;

soft magnetic composite pole pieces attached to the stator extension and facing the permanent magnet, each comprising a base portion and a trapezoidal shield portion the trapezoidal shield portion having a plurality of heights with a first height in a first region being longer than a second height in a second region the second region being closer to a pole-to-pole gap than the first region;
electrical coils each respective electrical coil wrapped around a respective base portion of a respective pole piece with a respective trapezoidal shield portion extending over at least part of the respective electrical coil.

[c17] 17. The machine of claim 16 wherein the pole pieces are optimally shaped to minimize leakage flux between adjacent pole pieces while maximizing magnetomotive force linking the electrical coils.

[c18] 18.The machine of claim 16 wherein the stator extension has slots and wherein each pole piece comprises a protrusion situated within a respective one of the slots, each protrusion shaped so as to facilitate orientation of the respective pole piece with respect to the stator extension.

[c19] 19.The machine of claim 18 wherein the protrusions extend from ledges of the pole pieces which are substantially parallel to the stator extension.

[c20] 20.The machine of claim 16 further comprising a circuit board situated adjacent to the stator extension and electrically coupled to the electrical coils.

[c21] 21.The machine of claim 20 wherein the circuit board comprises a circuit pattern configured for proper sequencing of the electrical coils.

[c22] 22.An axial flux machine stator comprising:
a soft magnetic composite stator extension;
soft magnetic composite pole pieces attached to the stator extension, each comprising a base portion and a trapezoidal shield portion the trapezoidal shield portion having a plurality of heights with a first height in a first region being longer than a second height in a second region the second region being closer to a pole-to-pole gap than the first region;
electrical coils each respective electrical coil wrapped around a respective base portion of a respective pole piece with a respective trapezoidal shield portion

extending parallel to the stator extension over at least part of the respective electrical coil.

[c23] 23. The stator of claim 22 wherein the stator extension has slots and wherein each pole piece comprises a protrusion situated within a respective one of the slots.

[c24] 24.The stator of claim 23 wherein the protrusions extend from ledges of the pole pieces which are substantially parallel to the stator extension.

[c25] 25.The stator of claim 22 further comprising a circuit board situated adjacent to the stator extension and electrically coupled to the electrical coils.

[c26] 26.An axial flux machine stator pole piece comprising:
a soft magnetic composite base portion;
a soft magnetic composite trapezoidal shield portion coupled to a first end of the base portion, the trapezoidal shield portion comprising a plurality of heights with a first height in a first region being longer than a second height in a second region, the second region being further from the base portion than the first region; and
a protrusion coupled to a second end of the base portion and shaped so as to facilitate orientation of the respective pole piece.

[c27] 27.The pole piece of claim 26 wherein the protrusion extends from a ledge of the pole piece which is substantially parallel to the trapezoidal shield portion.

[c28] 28.A method of fabricating an axial flux machine stator comprising attaching soft magnetic composite pole pieces to a soft magnetic composite stator extension by situating protrusions of the pole pieces within respective slots of the stator extension, each protrusion shaped so as to facilitate orientation of the respective pole piece with respect to the stator extension.

[c29]

29.The method of claim 28 further comprising, prior to attaching, situating a circuit board assembly adjacent to the stator extension, the circuit board assembly comprising a circuit board bobbins mechanically coupled to the circuit board, and electrical coils, each wrapped around a respective one of the

bobbins,

and wherein attaching comprises inserting the pole pieces through the bobbins to the stator extension.

[c30] 30.The method of claim 28 wherein each pole piece comprises a base portion around which a respective electrical coil is wrapped and a trapezoidal shield portion extending over at least part of the respective electrical coil.

[c31] 31.The method of claim 30 wherein each trapezoidal shield portion comprises a plurality of heights with a first height in a first region being longer than a second height in a second region, the second region being closer to a pole-to-pole gap than the first region.

[c32] 32.The method of claim 28 wherein the pole pieces are optimally shaped to minimize leakage flux between adjacent pole pieces while maximizing magnetomotive force linking the electrical coils.